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The Improvement of Forage Preservation in Bunkers and Stacks Through the Use of Temporary Seals[1/]

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The use of horizontal silos (trenches, bunkers and stacks has increased rapidly in the past few years. The distinctly lower initial cost per ton of storage capacity and the possibilities of fully mechanized filling and mechanical feeding or self feeding of the silage have contributed to its increased popularity. The basic disadvantage of horizontal silos is the large area of exposed silage as compared to the tower silo. This disadvantage is particularly objectionable with small silos or stacks. The most apparent result of having large areas of silage exposed to the air is the development of more surface spoilage but nutrient losses through leaching and generally lower quality of feedable silage may also result. Since any covering system that effectively seals the silage surface from the air would obviate the most serious disadvantage of horizontal storage, several attempts to provide such a seal have been made at this station.

Experimental Procedures and Results

A definition and separation of spoiled silage is, at best, rather arbitrary. Silage that was considered unfit for feeding to dairy cows on full feed was termed spoilage in these experiments. Separation of spoilage in all experiments was under the supervision of the same individual in order to make the error as unbiased as possible.

The sealing treatments of farm sized silos used in these experiments were usually incidental to some other experiment, hence proper control treatments were not possible. However, these results should be of value until more complete data are available. The bunkers used were 14'-16' wide, 8' high and 66' long. Sides were of matched lumber lined with rolled asphalt roofing and floors were of concrete. Stacks were

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on well drained sites and built directly on the ground. All silage was thoroughly packed with wheel tractors during the filling period.

The data pertinent to measurement of efficiency of dry matter preservation in the silages studied have been summarized in Table 1. Dry matter percentage of initial forage and total dry matter stored are presented as indications of the type and amount of forage stored in each experiment. The percentages of dry matter lost in seepage from these silos were relatively small when it is considered that seepage losses from high moisture forage stored in tower silos sometimes amount to 10-12% of the stored dry matter. Fermentation (calculated by difference) and spoilage losses accounted for the greater part of the differences in silo efficiency. It should be noted that the values for visible top spoilage represent only the dry matter remaining in this layer. It is likely that this layer suffered an additional gaseous loss of dry matter that was not visible nor recovered. Total losses associated with exposure are, therefore, probably larger than these data indicate. The percent of dry matter recovered for feeding is an overall measurement of ensiling efficiency. The percentage of stored forage that becomes top spoilage is clearly associated with the relative depth of the silage mass. Therefore, spoilage is also presented in terms of pounds per square foot of surface area, in order to facilitate comparisons between treatments applied to silos or stacks of differing depths.

Covers constructed from vinyl plastic 54" x .008" joined with pressure sensitive tape 4" wide were applied to two bunkers filled with 2nd cutting grass and clover in July, 1954. Bunker 1 contained unchopped forage and bunker 2 contained chopped forage. The covers were weighted at the edges with iron pipe and sawdust. Although the taped seams were made with extreme care and appeared to be air tight when first made, a differential in elasticity of the plastic and the tape subsequently resulted in small puckers in the tape at several points. Entrance of air through these small openings was evidenced by considerable movement of the cover during windy periods and by a large amount of spoilage when the covers were rolled back for feeding. The 6-7 pounds of spoiled dry matter per square foot of surface (Table 1) indicated this sealing technique to be unsatisfactory.

Unchopped and chopped first cutting grass was stored in bunkers 1 and 2, respectively, in 1955. The covering material originally planned was not available when the silos were filled so temporary covers of Sisal Kraft paper (6' width), lapped and weighted with a layer of fresh unchopped grass were applied the day after filling was completed. The temporary covers and the weighting forage were removed one month later and the permanent covers installed. The permanent covers were home-made from strips of 54" width neoprene coated nylon with cemented seams. Edges of the covers were weighted with railroad ties and the central portion was weighted with a 2-3 inch layer of sawdust. The top spoilage losses observed in this experiment (Table 1) indicated that this material and application technique materially reduced the losses observed the previous year in the same silos.

Table 1--Losses and recovery of silage dry matter stored in stacks and bunkers

Silo	Dry Matter Stored		Dry Matter Lost			Dry Matter Fed	Spoilage Per Sq. Foot	
			Seepage	Fermentation	Spoilage		Fresh Wt.	Dry Matter
	Percent	Pounds	Percent	Percent	Percent	Percent	Pounds	Pounds
1954 Hay Crop in Bunkers - 8 Mil. Vinyl, Taped Seams								
Bunker 1	29.1	53931	1.1	15.9	11.9	71.1	23.1	6.1
Bunker 2	28.7	62219	0.6	18.4	12.3	68.7	28.0	7.3
1955 Hay Crop in Bunkers - Sisal Kraft Paper Followed By Neoprene-Nylon Sheets								
Bunker 1	22.0	49573	2.5	22.2	4.2	71.1	10.6	2.0
Bunker 2	21.8	61133	3.3	20.9	3.2	72.6	8.7	1.9
1956 Hay Crop in Bunkers - Neoprene-Nylon Sheets								
Bunker 1	21.5	56894	3.8	8.7	0.5	87.0	1.2	0.2
Bunker 2	20.5	38524	2.4	6.8	1.3	89.5	3.2	0.5
1956 Hay Crop - Straight Sided Stack on Ground - 4 Mil. Polyethylene + Soil								
	21.3	41095	----16.0----		4.9	79.1	4.5	0.8
1956 Restacked Corn Silage - Mound Stack on Ground - Vinyl + Sawdust								
	24.5	38088	------Self-fed----------				<0.1	<0.1
1955 Pilot Stacks Built on the Ground								
Polyethylene	21.7	1293	-	-	-	-	3.6	0.9
Vinyl	22.9	1124	-	-	-	-	0	0

A layer of spoilage about 2" deep was observed under the Sisal Kraft paper at the time the permanent covers were installed. There appeared to have been no increase in the extent of spoilage after the neoprene coated nylon covers were installed, although this could not be accurately determined. The period of storage was more than 6 months including the entire summer.

Bunker 1 was filled with chopped first cutting orchard grass treated with 8 pounds of sodium meta-bisulfite per ton in May 1956. The neoprene coated nylon cover previously used on this silo was applied the day after filling. Railroad ties and sawdust were again used for weighting. The top spoilage resulting from this treatment was confined to small bands adjacent to each wall presumably caused by the non-tight juncture of cover and wall. The data in Table 1 show that total spoilage was reduced to an almost negligible amount (0.2 lbs. of dry matter per square foot of surface).

Chopped untreated orchard grass was stored simultaneously in bunker 2 and a shallow stack built directly on well drained ground. Average dimensions of the stack after storage were 72' x 27' x 3'. This forage was harvested May 15-18, 1956. Bunker 2 was covered the day after filling with the neoprene coated nylon sheet used the previous year and weighted in the same way. The stack was covered the same day with a 4 mil. black polyethylene sheet having heat sealed seams. The edges of the cover were weighted with soil and a considerable amount of soil was applied to the top of the stack so that only scattered patches of film were exposed. These silages were opened in December for feeding.

Preservation of the silage in bunker 2 was very efficient, 89.5 percent of the stored dry matter being fed. Very small amounts of spoilage appeared along the edges of the bunkers. This preservation value compares very favorably to losses one would expect from high moisture forage stored in tower silos. The seal used on the stack was of very definite value in reducing losses, although losses were markedly greater than those observed in the corresponding bunker. Application and removal of the soil was very laborious as compared to sawdust and resulted in cover damage to the extent that it was not reuseable. Spoilage on the stack was observed to be associated with small punctures of the film caused by stones in the covering material and with the nearly vertical sides of the stack where weighting material could not be held in place.

Corn silage, salvaged from a collapsed tower silo was used in August 1956 to construct a shallow stack. This silage which had been in storage 1-3 days was moved from the site of the old silo during a two day period and stacked. This stack was constructed with gently sloping sides in order that the packing tractor could drive over the stack in any direction. Several pieces of used vinyl film weighted with sawdust were used for sealing materials.

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Self feeding of this silage was commenced on January 24, 1957. Spoilage was entirely absent over the vast majority of the surface. The occasional small areas of spoilage were associated with breaks or tears suffered by the film during previous use. No measurements of spoilage were made because of the self feeding arrangement but it was estimated at less than 500 lbs. The pH values, occasionally determined, averaged about 4.0.

Pilot sized stacks made from 3rd cutting grass in September 1955 were covered with polyethylene and vinyl films. These were buried in soil at the stack perimeter but were otherwise unweighted. Some spoilage developed under the polyethylene cover during a three month storage period. Presumably this was caused by imperfect weighting of the perimeter during the first week of storage. No spoilage developed under the vinyl seal during storage until December when the stack was opened. Spoilage developed rapidly on that portion of the stack which was still covered after the initial opening. This demonstrated the importance of a weighting material for maintaining a seal during a normal feeding period even though a seal had been maintained up until that time.

Summary

The results of these experiments have demonstrated that several plastic type materials are satisfactory for preventing spoilage associated with exposure to air. However, these materials must be properly applied in order to obtain the desired result. A continuous layer of weighting material above the sealing cover is not theoretically necessary but is very desirable. Such a weighting material minimizes the effect of small injuries to the cover and allows one to maintain a seal on the major part of the silo after opening one end for feeding. From the standpoints of ease in applying and removing and reduced injury of the sealing film, sawdust was the most satisfactory weighting material used in these experiments.

The final choice, of which film to use, will depend largely on the yearly cost of each. Films supported by nylon which are now entering the third year of use are much more durable and less subject to accidental injury in handling. The unsupported vinyl and polyethylene films were both satisfactory but less durable. The vinyl film appeared to be more resistant to puncture and can be readily patched. The useful life of these materials will depend to a large extent on the care given them and the amount of patching a person is willing to do.

The preservation of up to seven pounds of dry matter per square foot which would otherwise spoil, makes manifest the economic advantage of silo seals for bunkers or stack silos. If forage dry matter were assigned the value of 1-1/2 cents per pound (equivalent to 15% moisture hay at $25.50 per ton) the sealing material would be worth 10-1/2 cents

per square foot, plus the unknown value of gaseous loss, plus the value of reduced leaching, plus the value of decreased labor for removal of the spoilage. The cost of any of the materials used will probably be less than four cents per square foot per year. Changing price schedules as well as the lack of information regarding the minimum thickness necessary and the expected life of the several materials, make it impossible to place fixed yearly costs on these materials. Seals should be particularly beneficial when the storage period is relatively long and/or includes the summer months.

Some unsupported films used in this experiment were furnished by the Baklite Company. The nylon supported films were furnished by the E. I. Du Pont Company. This report does not represent an endorsement of these products by the Agricultural Research Service over other companies or products not mentioned.